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RESPIRATION IN THE SAPWOOD AND HEARTWOOD OF *ROBINIA PSEUDOACACIA*

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Abstract—The respiratory activity of distinct sapwood and heartwood annual rings of the stem of *Robinia pseudoacacia* L. has been investigated. The oxygen uptake and the carbon dioxide release in the inner parts of the sapwood is enhanced in comparison with that in the outer parts. The heartwood rings have no measureable gas exchange.

INTRODUCTION

THE HEARTWOOD of trees is a plant tissue of great commercial interest and its formation has been the subject of several investigations.[1,2] Cytological[3] and physiological[4] studies have shown that there is a slow decrease in metabolic activity of sapwood annual rings in a tree with ageing. The heartwood contains only dead cells.

On the other hand there are some indications that the living cells of the sapwood go through a period of enhanced physiological activity just before their decay:[5] certain species having a distinctly coloured heartwood show a progressive increase in the nuclear volume,[6] in the amount of water-soluble vitamins[1] and in the specific activity of amylase[7] in the sapwood zone as it approaches the heartwood.

Similar contradictory phenomena as above mentioned characterize our knowledge about the respiratory activity of different zones of woody shoots: in oak stems, Zelawski[8] describes an increase in respiration during the logging season, while Japanese investigators[9] report a decrease in oxygen consumption in older sapwood zones of native trees.

RESULTS AND DISCUSSION

The oxygen consumption and the carbon dioxide release (related to nitrogen) of distinct annual rings of black locust are shown in Fig. 1. It is evident that the oxygen uptake in the inner parts of the sapwood compared with the outer parts of the stem is enhanced. The oldest sapwood ring (5th annual ring) shows the maximum of O_2 consumption. This is also

[1] ZIEGLER, H. (1968) *Holz als Roh- Werkstoff* **26,** 61.
[2] HILLIS, W. E. (1965) *Proc. Meeting Section* 41, IUFRO, Melbourne, Vol. I.
[3] FREY-WYSSLING, A. and BOSSHARD, H. H. (1964) *Holzforschung* **13,** 129.
[4] NECESANY, V. (1966) *Holzforschung Holzverwertung* **4,** 61.
[5] CHATTAWAY, M. M. (1952) *Aust. For.* **16,** 25.
[6] HUGENTOBLER, V. H. (1965) *Vierteljahresschr. Naturf. Ges. Zürich* **110,** 321.
[7] HÖLL, W. (1972) *Holzforschung* **26,** 41.
[8] ZELAWSKI, W. (1960) *Bull. l'Acad. Polon. Sci.* **8,** 509.
[9] HIGUCHI, T., FUKAZAWA, K. and SHIMADA, M. (1967) *Res. Bull. Coll. Exp. For.* **25,** 167.

true for the CO_2 release. The following rings (1st and 2nd heartwood rings) have no measurable gas exchange. The calculation of the respiratory quotient for the distinct annual rings (about 1) indicates that mainly carbohydrates, probably the supplied glucose, served as the substrate for respiration. The results show that after application of a suitable substrate (glucose) the innermost sapwood zone is able to use this compound for respiration to a high extent. One must keep in mind, however, the high substrate concentration of this experiment which is not found in this species under natural conditions. However, the potential for an enhanced respiration in the oldest sapwood tissues could be demonstrated. Recently Hillis[10] also obtained evidence of increased respiration in the transition zone between sapwood and heartwood.

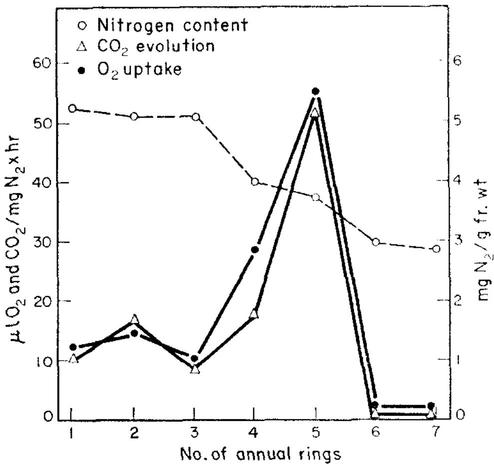

FIG. 1. RESPIRATORY ACTIVITY OF DISTINCT STEM ANNUAL RINGS OF *Robinia pseudoacacia*. Annual rings Nos. 1–5 represent the sapwood, while Nos. 6 and 7 are the outer part of the heartwood.

Microscopical examination of the wood material showed that microorganisms were not present to a significant extent and the gas exchange curves measured for 1 hr were linear. In blanks containing the reaction mixture alone, gas exchanges due to microorganisms which were higher than those in the samples containing wood could be measured only after 8 hr. These facts indicate that the measured gas exchanges are due to the physiological activity of the wood material.

EXPERIMENTAL

The tree (about 18-yr-old, exhibiting 5 sapwood rings) was cut in December 1970 near Munich (Allacher Forst). Tissues of distinct annual rings were filed from discs cut from the lower part of the stem. The tissues were frozen in liquid N_2 and homogenized in a mill to a fine powder.[11] To measure the respiration capacity 500 mg fr. wt. of each annual ring were incubated in the Warburg apparatus at 25°. Woody tissues inactivated by boiling for 1 hr were designated as blanks. In addition to the wood material the Warburg vessels contained the following reaction mixture: 4 ml of 0·3 M glucose in 0·1 M phosphate buffer pH 7·5. Vessels having KOH (0·3 ml, 10%) in their centre walls were used for O_2 uptake estimation and others having water instead of KOH were used for determination of CO_2 evolution. The vessels containing the wood were equilibrated in a water bath for 15 min. After that time the reaction mixture was added. After a further equilibration for

[10] HILLIS, W. E. (1972) *Phytochemistry* **11**, 1207.

[11] HÖLL, W. in preparation.

5 min, the stop cocks were closed and the readings were taken for 1 hr. These experiments were repeated twice, each with 6 replicates with almost the same results. The N_2 was measured following the procedure of Strauch.[12]

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[12] STRAUCH, G. (1965) *Z. Klin. Chem.* **3**, 165.